APPENDIX E
HISTORIC VEGETATION AND HEP STUDY

HEP STUDY

This Planning Aid Report (report) addresses the quality of some specific areas of wildlife habitat on lands owned by the Bureau of Reclamation (Reclamation) at Potholes Reservoir near Moses Lake, Washington. This report fulfills the requirements of fiscal years 1999 and 2000 scopes-of-work between the U.S. Fish and Wildlife Service (Service) and Reclamation. It has been prepared under the authority of the Fish and Wildlife Coordination Act (Act) (48 Stat. 401, as amended; 16 USC 661 et seq.). However, this report does not meet the requirements of Section 2(b) of the Act as a Coordination Act Report.

In the fall of 1998, Reclamation contracted with the Service to conduct a Habitat Evaluation Procedures (HEP) analysis on Potholes Reservoir. HEP is a species-based habitat analysis procedure. This report includes the results of that HEP analysis and will be used by Reclamation in completion of their Resource Management Plan (RMP) and Environmental Impact Analysis. The goals of the analysis were to: 1) acquire baseline data on current habitat conditions, 2) determine impacts from recreational use on wildlife/vegetative communities, 3) project habitat changes from the RMP alternative actions based on the Potholes HEP analysis, and 4) make management recommendations. This report will address the first and second goals. The third and fourth goals will be addressed in the Coordination Act Report that will be prepared by the Service based on this HEP report. The objective of the HEP was to quantify and describe current wildlife habitat conditions on Special Areas of Concern (SAC) and on adjacent control sites. SACs are those areas that are under consideration by Reclamation for management changes in the RMP alternatives and include:

Off Road Vehicle (ORV) areas:

green:	open to ORV use year-round
yellow:	open to ORV use from July 1 to October 1
red:	closed to ORV use year-round

Job Corps Dike
Proposed State Park site
Lind Coulee arm
Interior islands

STUDY AREA

Our study area included the land owned by Reclamation at the Potholes Reservoir near Moses Lake, Washington. The habitat within this area was heavily influenced by the creation of Potholes Reservoir behind O'Sullivan Dam, which was built about 50 years ago. The shallow water table behind the reservoir created many wetlands within an arid landscape dominated by shifting sand dunes, while also destroying most of the existing wetlands by submerging them under the reservoir. The study area is within Daubenmire's (1988) original *Artemesia-Agropyron* zone, which is the driest zone in the state (Franklin and Dyrness 1973).

Physical characteristics vary greatly among the SACs and control sites. The green ORV zone has many large sand dunes that are bare or sparsely vegetated with fragmented patches of upland vegetation in dune troughs, but contains few wetlands. Wetlands are sparse because the green zone is higher and set back further from the reservoir than the yellow and red zones. The yellow ORV zone has many wetlands and is more densely vegetated than the green zone. The yellow zone contains dunes that vary in size and amount of vegetative cover. Most wetland perimeters are vegetated, although some lack vegetation due to extensive ORV use. The yellow zone is bordered on the west by the Crab Creek channel of Potholes Reservoir. The red zone has smaller and more stable dunes. Throughout this area, vegetation is dense and cryptogams are present over the soil surface, and occasionally form a continuous layer. Wetlands in this area support stands of willow and dense perimeters of cattails. The red zone is supposed to be protected from use on the westside of Sand Dunes Road by a fence; however, it is broken and cut in many places. The eastside is unfenced and shows signs of unauthorized ORV use (WDFW 1997).

METHODS

As mentioned, HEP was the primary method used to evaluate and quantify habitat values for the Potholes Reservoir. The procedure assesses the value of the habitat for certain select species over the life of the project. The species evaluated are selected either to represent entire groups of species (for example, mallards may be used to represent dabbling ducks) or because of some special value they have in the area (for example, popular game birds). For this project, criteria for species selection included use of representative cover types, ecological importance, sensitivity to human and habitat disturbance and availability of adequate HSI models (Table 1).

Once species are selected, models which describe a range of habitat values for that species are written or existing ones are found. For this project, published models and those which had been used previously were selected. The models are based on published research on a particular species, as well as input from experts on the species. These models generally relate certain aspects of the habitat, such as percent ground cover or height of vegetation, to the value of the habitat for the species. The models used, the variables measured, and the model equations used can be found in Appendix A. The measurement of a variable which may be important to a particular species (for example, height of shrubs) is scored on a scale from 0.0 to 1.0, with 0.0 being of no value and 1.0 being of highest value. The score for that variable is termed a suitability index (SI). An equation is then used which relates the variables in some manner. For example, if the first variable (V1) is deemed two times as important as the second variable (V2) by the literature and experts, then the equation in the model may appear as $2(V_1) + V_2$. The results of these equations are as habitat suitability indices (HSI) and may change over time as the habitat changes. In most models, once the HSI scores are determined for each species, they are multiplied by the number of acres of habitat available to the species to derive a measure which takes into account both the habitat quality and quantity. This unit of measure is called a habitat unit (HU). As an example, five acres of habitat which has an HSI of 0.3 for a species would result in 1.5 HUs for that species. The HUs can then be calculated over time to account for changes in the number of acres of habitat available to a species or by changes in the quality of the available habitat over the life of the project.

Table 1
List of selected evaluation species with justification

Species	Reason For Selection
mule deer (Odocoileus hemionus)	Important big game species
western meadowlark (Sturnella neglecta)	Indicator species for grass/shrub-steppe
western sage grouse (Centrocercus urophasianus)	Indicator species for shrub-steppe
western grebe (Aechmophorus occidentalis)	Indicator species for island nesting birds
mallard (Anas platyrhynchos)	Indicator species for waterfowl habitat associated with backwater/ponded areas
mink (Mustela vison)	Indicator species for riparian forested/scrub- shrub and emergent wetlands
yellow warbler (Dendroica petechia)	Indicator species for scrub-shrub wetlands
beaver (Castor canadensis)	Indicator species for riparian forests

After evaluation species and appropriate models have been selected, the next task is normally cover-typing. This involves separating out the various classes of habitat, based on the species needs. In this case, vegetative cover classes were identified through the use of a GIS cover type map provided by the Dames and Moore consulting firm, as well as by viewing aerial photos. The study site contains a variety of cover type classes as shown in Table 2.

To quantify habitat conditions, transects were used to measure various vegetation characteristics. Vegetative data were collected in July and August of 1999. Although these dates were not ideal for assessing the condition of the habitat for nesting birds, since most nesting in the Potholes occurs much earlier in the spring, it was unavoidable due to Service staffing constraints.

Two biologists with the Service were the core sampling group. Occasionally others assisted with some sampling. A variety of methods were used to sample vegetation, from traditional methods that were recommended in the species' models (for example, Daubenmire grid, Robel pole, line intercept) to ocular estimates for unique situations (for example, when habitat occurred as very narrow strips). We intended to select transect starting points and azimuths randomly, but due to high interspersion of cover types, starting points and azimuths had to be arbitrarily placed to keep each transect within the same cover class. Occasionally, transect azimuths were changed part way through the transect to remain within the target cover class.

Cover types occurring in extremely low proportions were disregarded. For example, the green zone contained less than eight acres of grassland, therefore data was not collected in this cover type.

Table 2
Dominant cover types in the project area

Cover Type	Description
Shrubland	>15% to 25% shrub cover
Dense Shrubland	>25% to 35% shrub cover
Very Dense Shrubland	>35% shrub cover
Riparian Scrub Shrub	hydrophytic shrubs in riparian zone (including Russian olive), a single polygon includes both sides of stream
Riparian Shrub	hydrophytic shrubs in riparian zone (excluding Russian olive), a single polygon includes both sides of stream
Riparian Scrub Forest	>40% canopy cover trees (including Russian olive) in riparian zone, a single polygon includes both sides of stream
Riparian Forest	>40% canopy cover trees (excluding Russian olive) in riparian zone a single polygon includes both sides of stream
Emergent Wetland	dominated by wetland species (cattail, bulrush, spikerush, etc.)
Surface Water	pond, lake, reservoir, wide river (water-body devoid of emergents)
Exposed	sand, ash, mud flat (soil substrate devoid of vegetation)
Island	permanent substrate separated by >20 feet from shore
Urban	residential or industrial

Upland Habitat:

Large homogeneous habitat areas were chosen using GIS cover maps, as well as aerial photos. In most cases, two transects within each cover type were used that totaled 1000 feet each. This is generally considered adequate for a HEP analysis.

A Daubenmire grid (1 x ½ m) was used to assess horizontal cover at 25 foot increments, while a Robel pole was used to measure vertical cover at 50 foot increments along the transect. Four measurements were taken with the Robel pole (one in each direction) at each interval and then averaged and recorded in decimeters. The line intercept method was used to measure shrub cover along the entire transect. Shrub intercept and height were recorded by species using a tape measure and recorded in inches. When transects crossed small inclusions of another cover class (<50 feet), no data were collected.

Because of an oversight, data on the distance to perch sites for the western meadowlark model was not collected in the field. To accommodate for this, the SI for that factor in the model was set at 1.0 for all transects. Although this may give the appearance that meadowlark habitat is in better condition than it likely is, it maintains the ability to compare the other factors in the model among the various SACs and control sites.

Wetland And Riparian Habitat:

In the ORV zones, and their controls, 600' transects were run perpendicular to the waters edge and into the uplands. Because the Potholes Reservoir water level undergoes extreme annual fluctuations "water's edge" was defined as two feet below high pool elevation. That is because that pool elevation is the average on May 31, when most mallard broods have hatched.

Two data collection methods were used to assess wetland and riparian habitat quality. Line intercept was used to assess shrub cover and quality, while the Daubenmire grid was used every 25 feet to record herbaceous cover. Herbaceous cover within the wetland and riparian areas included shrub cover, because of the wetland evaluation species' models. This is contrary to upland cover in which herbaceous cover was comprised of only grasses and forbs.

At least one transect was completed within each cover class per SAC and control site. Since many wetland and riparian transects had less than 50 feet within the cover type, an additional ocular HEP was used to characterize the entire wetland basin being sampled. The ocular measurements helped quantify the entire wetland, while the traditional methods measured specific points. With fringes of narrow wetlands, inaccurate estimates are more prone to surface using the traditional methods. For most cases with wetlands, the ocular estimated were used since the number of traditional measurements were very low.

The Proposed State Park area does not contain enough wetland or riparian habitat to support mallard or mink populations, therefore only upland transects were run there. The riparian data collection for the Lind Coulee site was ocular along with its control, which was about one mile to the east. Again this was done to minimize sampling errors at these narrow cover types.

The Job Corps Dike and its control area were handled differently from all other sites because of the presence of a riparian forest. To assess this habitat, the beaver model was used and the data collection was ocular. The ocular measurements helped to minimize sampling error due to the sporadic nature of the riparian forest.

Islands:

The western grebe model was selected to assess the island habitat in the Potholes Reservoir; however, no field data were collected on the islands. Motor boat activity during the nesting season would result in an HSI value of zero for this species. Therefore, since there is extensive motorboat activity in and around sheltered bays and emergent wetlands of Potholes Reservoir, there was no need to collect additional data.

Controls:

Control sites were selected for all SACs to assess what their potential HSI would be in the absence of ORV use. Controls were chosen in areas that were located in close proximity to the respective SAC and that also contained similar topography, cover types, and soils. Control areas were not pristine; they have likely been burned and grazed in the past but have not been open to ORV use.

RESULTS

SI values for each model variable for each species is listed in Appendix B. The variable numbers (for example, V_1), correspond with the variable numbers in the evaluation species' models. In some cases, there is a break in the numbering sequence since we did not use all of the variables included in the models. For example, some of the models have variables that are only used if certain habitats or conditions are present. HSIs calculated from the SIs are presented in Table 3. They were first calculated for each transect and then combined with all transects in the same

Table 3
HSI values for all SACs and control sites in the Potholes Reservoir study area

Upland Species	**UG**	**UY**	**UR**	**UORVC**	**ULC**	**ULCC**	**USP**	**Islands**
Sage grouse (breeding)	0	0	0	0	0	0	0	
Sage grouse (wintering)	0	0	0	0	0.4	0.5	0.5	
Sage grouse (overall)	0	0	0	0	0	0	0	
Mule deer	0	0	0	0.1	0	0.2	0	
Western meadowlark	0.6	0.6	0.8	0.6	0.8	0.6	0.4	
Western grebe								0
Wetland Species	**WG**	**WY**	**WR**	**WORVC**	**WLC**	**WLCC**	**JCD**	**JCDC**
Mallard (wintering)	0.9	0.9	0.9	0.9	0.9	0.9		
Mallard (nesting)	0.1	0.3	0.4	0.6	0.8	0.7		
Mallard (brooding)	0	0.1	0	0.1	0.1	0.1		
Mallard (overall)	0	0.1	0	0.1	0.1	0.1		
Yellow warbler	0.6	0.6	0.7	1.0			0.9	0.8
Beaver (winter food)	0.3	0.3	0.4	0.3			0.7	0.7
Beaver (water)	0	0.5	0.2	0.2			0.2	0.2

Table 3
HSI values for all SACs and control sites in the Potholes Reservoir study area

Beaver (overall)	0	0.3	0.2	0.2			0.2	0.2
Mink (water)	0	1.0	0.6	0.6	1.0	1.0		
Mink (cover)	0.7	0.6	0.7	0.9	0.5	0.7		
Mink (overall)	0	0.6	0.6	0.6	0.5	0.7		

UG-upland green ORV UY-upland yellow ORV UR-upland red ORV UORVC-upland ORV control ULC-upland Lind Coulee ULCC-upland Lind Coulee Control USP-upland state park WG-wetland green ORV WY-wetland yellow ORV WR-wetland red ORV WORVC-wetland ORV control WLC-wetland Lind Coulee WLCC-wetland Lind Coulee control JCD-Job Corps Dike JCDC-Job Corps Dike Control

SAC or control site to get the average HSI for that area.

The blanks in Table 3 indicate that species was not modeled for that particular area because of a lack of suitable cover types. As noted in Table 3, there were several HSIs which were zero, indicating suitable habitat was not present in those SACs or control sites for that species, according to the model. Sage grouse HSIs equaled zero in nearly every area. Mule deer HSIs were zero in all areas except the ORV control and Lind Coulee control sites. Most of the meadowlark HSIs were fairly high. While the mallard wintering HSI was high for all areas, the overall HSI was either zero or very low since it is determined by looking at the lowest of the three HSIs (wintering, nesting and brooding). The only HSI of 1.0, indicating optimal habitat conditions, was for yellow warbler at the ORV control site. All of the sites had high yellow warbler HSIs except for the green and yellow zones.

Because of the timing of the data collection, the forb component was likely under-represented in the Daubenmire plots. Since the goal of the HEP is to compare the current condition of the SACs to control areas and the impact of the late season data collection would be the same across all areas, it should not unduly influence the conclusions reached in this study.

DISCUSSION

One of the goals of the HEP analysis was to determine impacts from recreational use on wildlife/vegetative communities. From our field observations and preparation of this report, we believe that such impacts may be partially masked by the condition of the land before recreational impacts began occurring. For example, all areas were heavily grazed in the early part of the century, which resulted in the destruction of native plant cover and the formation of extensive areas of active dunes (Zook 1978). Fire also likely impacted the native shrub-steppe habitat. Due to the arid climate and sandy soils, recovery of native vegetative communities is slow. Additionally, Franklin and Dyrness (1973) indicate that the uplands here are fragile and susceptible to invader plant establishment on disturbed sites. The competition by these invaders, many of which are also non-native, further hampers recovery of native communities.

The Washington Department of Fish and Wildlife, in the summer of 1999, completed a HEP analysis on the Desert Habitat Management Unit (HMU). The Desert HMU is immediately west of and adjacent to Potholes Reservoir and encompasses the same upland and wetland cover types with the exception of the Potholes Reservoir itself and the interior islands there. The Desert HMU has not been open to ORV use and has not been grazed by livestock in over 30 years. A comparison of the two sites (Table 4) shows that the Desert HMU has less exotic vegetation, more overall shrub cover, and a greater percentage of that shrub cover which is sagebrush. Rabbitbrush, much more common in the Potholes Reservoir study area, increases with disturbance while sagebrush is very slow to recover from disturbance. Sagebrush was an important component of native shrub-steppe habitat in the area (Daubenmire 1988) and is a preferred forage species for mule deer and a required winter forage species of sage grouse. However, it was much less common at the Potholes Reservoir study area than at the Desert HMU. Comparing the Desert HMU and Potholes Reservoir study areas, indicates that it would likely take many years without disturbance for the habitat at Potholes (particularly, upland habitat) to recover, and it may require active restoration.

Table 4
Canopy cover at the Desert HMU and Potholes Reservoir study areas

% total cover that is:	**Desert HMU**	**Potholes Reservoir**
Exotics	22%	66%
Native shrubs	25%	13%
% native shrub cover that is:		
Rabbitbrush	44%	61%
Sagebrush	44%	23%
Bitterbrush	2%	15%
Total # native shrub species*	9	3

*only species with at least 1% canopy cover were counted

However, with wetland communities, restoration of impacted areas can be quicker. This is due to the artificial water sources provided by the creation of Potholes Reservoir and the Columbia Basin Irrigation Project. This difference between wetland and upland habitats can also be seen by comparing HSIs of wetland and upland species. Overall, HSIs are much higher for wetland species than upland ones. This is not to say that recreational impacts have not occurred to wetlands. Wetland communities have been impacted by roads (primarily by informal ones) and through ORV use. Also, several wetlands in the green ORV zone have been virtually denuded of vegetation by recreational activities.

As already mentioned, several of the HSI's ended up being zero. It should be noted that an HSI of zero does not necessarily mean that the species would never be present. It could be that adequate habitat is present adjacent to a project area and the species is able to exist in low numbers within the project area, as long as it has access to the adjacent habitat. Also, it could be that for the particular area, the model should be adjusted to account for local conditions. Finally, while the species may be present in some capacity, using habitat which has an HSI of zero could result in low or no reproduction.

Overall and breeding sage grouse HSIs were zero for all sites on the study area. The nesting HSIs were also zero for all but the Lind Coulee sites and the State Park site. This is primarily due to very little sagebrush cover on the SACs and control sites. The sites were also low quality habitat for sage grouse due to a high percentage of herbaceous cover and a high percentage of the cover being exotic vegetation. While it was understood that there were no sage grouse on the study area before the model was selected, it was assumed the model would still be a good representative for several other shrub-steppe species. However, the relatively high threshold of sagebrush cover needed was problematic for this study area using this model.

Additionally, the mule deer HSIs were zero in all but two sites, although they are present in the study area. The low habitat quality present appears to be a reflection of low canopy cover of preferred winter forage species (such as sagebrush, bitterbrush, and rose) and lack of taller shrubs for cover. The two sites which had higher than zero HSIs, were ORV control and Lind Coulee control. This may indicate that recreational activities likely impact mule deer habitat, or at least prevent it from recovering.

The meadowlark HSIs were all fairly high, which could partially be due to having to assign a SI score of 1.0 to V_4 (distance to perch) for each site due to the previously mentioned oversight in data collection.

The wintering HSI for mallard was rated as very high, which can be evidenced by the heavy hunting pressure for waterfowl present at Potholes Reservoir into December. However, nesting and brooding HSIs habitat quality was generally very poor, especially in the green and red ORV zones. The main limiting factor to mallard nesting appears to be human disturbance. The yellow ORV zone had slightly higher HSIs than the green or red zones, probably due to the influence of more water and faster recovery from impacts. Nesting HSIs were higher at the control sites than the ORV zones because of better nesting cover. This helps show that ORV and other recreational activities have probably either reduced the quality of mallard nesting cover or at least prevented it from improving over time. The low HSIs for brood rearing were mostly due to the presence of carp which impact water quality and decrease habitat quality for aquatic invertebrates.

Yellow warbler HSIs were fairly good to optimal throughout the study area. This is due in part to their preference for wetland shrubs, such as willows, which can grow fairly quickly, as long as germination and moisture conditions are adequate. The ORV zones had slightly lower yellow warbler HSIs than other sites, possibly due to impacts from ORV use and other recreational activities. In addition, the lower HSI in the green ORV zone may also be due to most wetlands there not having hydrology as long during any given year, compared with red and yellow zones. While the yellow warbler HSI for the green zone was 0.6, it must be noted that wetland shrub habitat was uncommon here, due in part to frequent disturbance from ORVs and other recreational activities. It should be noted that recreational activities at the Job Corps Dike do not appear to have impacted yellow warbler habitat, as it was slightly higher there than at the adjacent control site, and was higher than the three ORV zones.

As could be expected, beaver winter food HSIs were highest in the areas with the riparian forest. However, they do use areas without larger trees, and in fact the yellow ORV zone had a slightly higher HSI than the other sites, though it has few trees. The green zone had an overall HSI of 0.0 which was the result of water not being present long enough throughout the year. It appears that recreational activities at the Job Corps Dike have not adversely impacted beaver habitat as the individual and overall HSIs were the same here as at the control site.

Mink habitat is generally good across the sites sampled, but would be improved by higher shrub canopy cover in the wetlands. The exception is the green zone which had an overall HSI for mink of 0.0. Again, this was due to water not being present here enough through the year. Mink habitat was lower quality at the Lind Coulee site than the adjacent control site. Lower values here for mink, as well as for sage grouse wintering and mule deer habitat, may indicate that recreational activities such as dispersed camping have reduced habitat quality or prevented its' recovery. However, this speculation is confounded by the fact that HSIs for western meadowlark and mallard nesting were slightly higher here than at the control site.

The HSI for western grebes for the islands was zero, while western grebes are definitely present at Potholes Reservoir. Motorboat and personal water-craft activity in and around sheltered bays and emergent wetlands during the April to July nesting season caused the HSI to be zero. This could help answer why western grebe reproduction appears to be poor at Potholes Reservoir. Based on the HEP model used, grebe nesting is also limited due to the extreme water level fluctuations within the reservoir during the nesting season.

The habitat quality at the State Park site indicates it was in poorer condition than the other sites measured, except regarding sage grouse wintering habitat. Placement of this type of facility should take into consideration the habitat quality affected. The impact of the placement of this facility in this location should also be examined to see if increased visitation and use would adversely impact adjacent areas.

While there were limitations to this HEP study as mentioned earlier (such as, timing of data collection, omission of a meadowlark variable, and use of the sage grouse model which resulted in minimal data), useful data was obtained. This report established some baseline information on habitat quality at Potholes Reservoir. This information showed that habitat quality in the Potholes Reservoir study area is generally poor to moderate. Also, it appears that recreational activities, especially ORV use, have lowered habitat quality, or at least prevented it from recovering from previous conditions. Previous land-uses, such as over-grazing, coupled with an arid climate and sandy soils, resulted in lower habitat quality in the study area before recreation activities began. Additional information on current and historic habitat conditions at Potholes Reservoir, the impact of current and historic management, and recommendations for future management will be presented in the Coordination Act Report which will shortly follow-up this report.

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DRAFT HISTORIC VEGETATION STUDY

INTRODUCTION

This study is an attempt to address impact from various recreational uses on vegetation cover types at Potholes Reservoir. A study was completed using two vegetation cover type maps to compare the historic or reference vegetation of certain portions of the study area with the vegetation that is currently there. Specifically, the vegetation types in the ORV park and a control area were delineated before and after the establishment of the ORV park. Other areas were also compared to address the issue of dispersed camping impacts in combination with the HEP study.

The following question was to be addressed by this study (compare historic or reference cover types and present cover types at the ORV park).

Question 1. How much wildlife and habitat benefit would be derived from restricting ORV use compared to how much additional impact would occur if additional lands were open to ORV use?

The remaining questions were to be addressed by this study in tandem with the HEP study conducted by USFWS.

Question 2. How much wildlife and habitat impact would occur from developing a new campground or directing recreation activities to specific "designated" use areas?

Question 3. How much wildlife and habitat benefit would be derived from restricting personal watercraft and motorboat use to certain parts of the reservoir?

Question 4. How much wildlife and habitat benefit would be derived from limiting dispersed camping to certain reservoir areas?

METHODS

Aerial photographs were obtained from the Reclamation. The most recent photos available were taken April 28, 1994 and cover the entire study area. They are infrared, 1:12,000 scale photos. For the historic vegetation map, there was no single set of photos with coverage of all of the study area. Two sets were used--one from June 29, 1971 and the other from September 9, 1964. Both sets are black and white and range in scale from 1 : 3500 to 1 : 5000.

The historic vegetation map covers 6220 acres in portions of the following management zones: Dunes/Sand Islands, Eastern Bluffs and Dunes, Upper and Lower Crab Creek Arm, North Potholes Reserve, O'Sullivan Site, Peninsula North and South, and the Upper West Arm. Complete coverage is available for the red and yellow zones, the ORV control area, the Job Corps Dike North and South, and the proposed state park area (O'Sullivan site), while only about half of the green zone has coverage.

Vegetation cover types were delineated from the photos using photo interpretation and ground observation. Table 1 lists the cover types that were used and their definitions; the cover types were designated by the Reclamation. The polygons (vegetation cover types) delineated from the aerial photos were then digitized into the GIS database for Potholes Reservoir RMP. Two maps were generated in this way--current and reference or historic. The current vegetation map was spot checked in the field to verify its accuracy; the reference vegetation map was checked against the original drawing. Corrections are reflected in the final maps.

Acreages were then calculated from the GIS database for all cover types on the historic vegetation map and the corresponding area on the existing vegetation map.

Comparisons between the historic and current vegetation include only those areas covered on both GIS maps. Comparisons were made between overall acreages, and between specific points throughout the covered area. Also, the ORV control area and the green and yellow zones for both current and historic conditions were compared against each other.

RESULTS

Table 1 shows the existing vegetation mapped from the 1994 photos. Table 2 shows the reference vegetation mapped from 1964 and 1971 photos. Acreages of the cover types the entire study area and specifically for the zones of the ORV park, including the ORV control area, and the proposed state park are shown in Table 2.

There are at least four differences that immediately stand out when comparing either the maps or the acreages. The first is the finer level of detail shown in the reference vegetation map. There are numerous small polygons (<5 acres) in that map, which show the vegetation as a detailed, complex array. The existing vegetation map has larger polygons, which forms a relatively uniform pattern in the vegetation cover types.

Other differences are created by the effects the water level has on cover type acreages and distribution. There are 2392 acres of water shown on the existing vegetation map compared to only 853 acres on the reference vegetation map. The amount of wetland emergent vegetation is very different--1177 acres historically and 241 acres currently. Also, the mud flats that had only recently been exposed by receding water in photos taken in June of 1964 were classified as the exposed cover type. Polygons of the exposed cover type that are adjacent to water are rare in the existing vegetation map.

The patterns of wetland vegetation on both maps are different, which is related to the above (the water level difference). In the reference vegetation map, existing wetland vegetation that is not covered by water is classified as riparian shrub and riparian forest, but the pattern is very different than what is shown on the existing map. The west piece of the study area (Job Corps Dike area) is almost entirely riparian forest on the existing map, while the corresponding area of reference vegetation is riparian shrub. Wetland emergent is also shown in that area on the reference map, but is assumed that this would be covered with water at full pool. Finally, in the Upper Crab Creek Arm, the riparian shrub reference vegetation is clearly shown as riparian forest on the existing vegetation map.

Finally, the pattern of shrub grass and shrubland cover types differs. Most of the existing upland ORV control area is classified as shrubland, whereas this area of reference vegetation is classified as shrub grass. This is also seen in the existing green zone where there are only two cover types shown, while the reference map shows large areas of shrub grass in addition to shrub and exposed.

There are other, less obvious differences. The total acreage of reference wetland vegetation cover types (including water and excluding exposed) is 2623 acres compared to the existing 3495 acres, a “gain” of about 875 acres. There is a difference that somewhat corresponds in the number of upland cover types acres: 2929 (reference) and 2403 (existing), a “loss” of about 525 acres.

The amount of existing grassland (183 acres) is similar to the historic amount (211 acres). But, comparing the distribution of grassland polygons between the two maps points out how the maps differ spatially. The existing vegetation map shows grasslands to be scattered throughout the east side of the yellow zone and in an near the O’Sullivan site. The reference vegetation map shows large patches of grasslands in the ORV control area and southward and in the area north of the red zone. The existing vegetation map shows grassland in many places where wetland emergent and exposed were mapped for the reference map.

The percent cover of shrubs in the study area has increased dramatically since 1964; areas classified as shrub grass are now shrubland, and areas classified as grassland are now shrub grass or shrubland or even dense shrubland. There was much more grassland historically.

The definition of the exposed cover type includes sand (dunes) and mud flats (Table 1). The reference vegetation map has exposed in two areas--where water had (apparently) receded recently in the yellow and red zones and on bare, presumably active sand dunes in the southern part of the ORV Control area and in the red, yellow, and green zones. A total of 577 acres was mapped as this cover type. The existing vegetation map has 292 acres of exposed. For the most part, it is restricted to the southern part of the ORV control area and in the green zone, all of which is in the uplands as bare sand dunes.

Results relevant to Question 1. *Uplands*. In the green zone there is more area that is exposed now than there was historically. This is easily seen in Section 21. The numbers are clear: 92 acres historically and 179 acres in 1994. There is no corresponding change in the ORV control area between current and historic; in fact, there is roughly the same amount of exposed cover type (21 acres historically, 17 acres in 1994) now than before. There was a dramatic increase in vegetation cover in red zone: 93 acres of exposed historically and 9 acres currently. There was a similar change in the yellow zone: 259 acres of exposed historically and 16 acres currently. Almost all of the exposed polygons on the reference vegetation map are exposed wetland areas. Comparing the two maps shows grassland, wetland emergent, and water on the existing vegetation map in place of the exposed areas on the reference vegetation map.

Results relevant to Question 1. *Wetlands*. In the ORV control area, there is currently more area designated as wetland than on the historic map (380 acres, 241 acres). Also, across the entire study area, most of the wetlands that were classified as riparian shrub are now classified as riparian forest. The decrease in wetland emergent from past to present is probably because the wetland emergent was underwater when the photo was taken in 1994. Some wetland emergent areas now have shrubs and trees. Comparing the green zone of the past with the present shows that the wetlands are about the same. There was more riparian forest in the green zone historically, which is different than all of the other areas.

Results relevant to Question 2. The cover types at the O'Sullivan site currently appear to be similar to those in the past. There has been no outstanding change. Regarding the second half of this question--directing recreation activities to specific areas--this study does not, in itself, provide enough information to produce an answer this question.

Results relevant to Question 3. The vegetation maps indicate an overall increase in the number of acres of wetlands in the study area (2623 acres to 3495 acres when water is included). The amount of riparian shrub and riparian forest changed from 593 acres to 862 acres.

Results relevant to Question 4. No data derived from this study alone can answer this question.

DISCUSSION

The limitations and specific problems with this study are detailed in Appendix A. For the most part, the problems are due to the quality of the 1964 and 1971 photos. There is difficulty in comparing the photo interpreted results of data that is derived from such different sources. When analyzing the results of this study, it is important to realize that correlation does not show causation. The vegetation maps can only show change over time; they do not show the cause of change. Change can only be inferred. However, there is direct evidence of ORV vegetation damage throughout the personal observation of biologists. Similarly, the community composition of the vegetation in the yellow and green zones includes a high number of weeds, including designated noxious weeds. The plant communities in the ORV park are composed of disturbance-oriented species, whereas, the communities in similar areas in the ORV Control area are composed primarily of native species. Also, the vast network of roads and trails in the yellow and red zone does not appear on the reference vegetation map. This is a highly fragmented landscape that correlates well with ORV use.

With regards to specific results listed above, the reference vegetation map was drawn from larger scale photos and it was possible to differentiate smaller polygons. For the existing vegetation map, small polygons were "lumped" into adjacent cover types. Since a minimum mapping unit was not specified, the photo interpreter had more freedom in making determinations.

It is difficult to quantify the impacts to wetlands since there is such a disparity between the water level of the current and historic maps. However, it is reasonable to assume that the wetland emergent and exposed areas adjacent to the wetlands would be underwater at the full pool level of the 1994 photos. Very little, if any, of the mud flats classified as exposed would have remained unvegetated; later in the year they would have been classified as wetland emergent. At full pool there is very little exposed cover type adjacent to water.

The differing pattern in woody wetland vegetation is difficult to analyze. The apparent conversion of large tracts of riparian shrub to riparian forest, in the Job Corps Dike area, for example, may be a product of photo interpretation technique. Or, trees may have colonized the area.

The same reason can be used to explain the increase in wetland cover type area in general and the decrease in upland cover type area.

Differentiating between the shrub grass and shrub cover types is difficult. This may account for the acreage difference of these cover types. Polygon size and the patchiness of vegetation are factors in determining cover types, particularly when the difference is an arbitrary cut off. The shrub grass cover type is defined as having 5-15% shrub cover; the shrub cover type has 16-25% shrub cover. The disparity in acreages could simply be a result of the notoriously problematic nature of estimating percent plant cover. It is a well-documented fact that this method cannot give a precise vegetation measurement (Barbour et al. 1999), but it can provide an overall picture. If these two types are lumped together, the acreage is still very different but it is closer (2663 acres historically versus 2010 acres currently).

To discuss changes in the amount and distribution of the exposed cover type, it must be understood that this cover type represents two areas that have different edaphic characteristics and may support different types of vegetation. The areas include recently exposed mud flats and upland sand dunes. The mud flats that were "exposed" after the water receded most likely had not yet been colonized by wetland emergent plants when the photos were taken. Or, the old photos were not clear enough to make that distinction. In any event, these areas are underwater on the existing vegetation map. This partly accounts for the overall decrease in exposed cover type acreage (577 acres to 292 acres).

<u>Question 1.</u> *Uplands*. There is more exposed area in the green zone now than in the past (179 acres now from 92 acres historically), all of which is and was upland sand dunes. The green zone is the only portion of the study area that clearly shows an increase in exposed area. Although the results are not as strong as one would think they would be after observing this area, they do show that shrubland habitats in the area are being converted to bare, active sand dunes. In the red and yellow zones, the amount of exposed cover type decreased dramatically (352 acres to 25 acres). This decrease is the result of the higher water level as discussed above. However, when comparing only the upland exposed areas, it appears that these areas are now colonized by shrubs. Not only is the green zone being denuded, shrub cover is not increasing as it is in other parts of the study area.

<u>Question 1.</u> *Wetlands*. There is no clear picture of the changes in wetland vegetation cover types and how those changes are related to impacts.

<u>Question 2.</u> The development of a campground is a high impact project, in terms of ground disturbance. The area will be completely changed. However, the current conditions of the area are poor to extremely poor. The area is already receiving a lot of use; in addition, there is significant erosion from the roads, shoreline, and the overall loss of vegetation. The vegetation in the area is dominated by cheatgrass (*Bromus tectorum*) with patches of gray rabbitbrush (*Chrysothamnus nauseosus*), and a few patches of remnant big sagebrush / Sandbergs bluegrass (*Artemisia tridentata* / *Poa secunda*). Also, crested wheatgrass (*Agropyron desertorum*) has been seeded in a portion of the area. Basically, the area is dominated by exotic, invasive species typically found in arid, disturbed environments of the region. With the exception of last

community, it appears that the area has been reclaimed (naturally except for the seeded crested wheatgrass) from a range fire or from agricultural use. Without a long-term restoration commitment, which would be expensive, this area will not return to valuable wildlife habitat with its current level of use. Campground development of this area would be an excellent use of the land. Presumably, this action would draw users that otherwise use dispersed camping thereby reducing that impact to the Potholes study area in general.

<u>Question 3.</u> It is unclear why the amount of woody wetland vegetation increased in the study area. It could be due to mapping error. Or, woody vegetation may have colonized more wetland area. The impact to these wetlands from motorboat use is unknown.

<u>Question 4.</u> Even though there is no data derived from this study alone to definitively answer this question, it is reasonable to assume that the disturbance caused by dispersed camping can be somewhat ameliorated by concentrating the use to certain areas. Dispersed camping impacts to vegetation are weed introduction, increased fire hazard, and disturbance of vegetation itself and to soils. Also, dispersed camping "spots are eventually converted from native vegetation to weedy areas dominated by fire-prone species.

REFERENCES

Barbour, M. G., J. H. Burk, W. D. Pitts, F. S. Gilliam, M. W. Schwartz. 1999. *Terrestrial Plant Ecology*, Third Edition. Addison Wesley Longman, Inc. Menlo Park, California.

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Table 1
Cover Types Used in the Reference Vegetation Study

Cover Type	**Code**	**Description**
Agriculture	AG	various grain or hay crops including mowed forbland
Grassland	G	< 5% shrub (ex. Cheatgrass, blubunch wheatgrass)
Shrub Grass	SG	> 5% to 15 % shrub cover
Shrubland	S	> 15% to 25 % shrub cover
Dense Shrubland	DS	> 25% to 35 % shrub cover
Very Dense Shrubland	VDS	> 35% shrub cover
Riparian Shrub	RS	hydrophilic shrubs in riparian zone, a single polygon should include both sides of the stream
Riparian Forest	RF	> 40% canopy cover trees in riparian zone, a single polygon should include both sides of the stream
Emergent Wetland	WE	dominated by wetland species
Surface Water	W	pond, lake, reservoir, wide river
Exposed	E	sand, ash, mud flat
Urban	U	residential or industrial

Table 2
Reference Vegetation Study Area Acreages

Cover Type	Reference Acreage	Existing Acreage
Water	853	2392
Wetland Emergent	1177	241
Riparian Shrub	516	409
Riparian Forest	77	453
Wetland Total	2623	3495
Grassland	211	183
Shrub Grass	1568	433
Shrubland	1095	1577
Dense Shrubland	55	175
Very Dense Shrubland	<1	35
Upland Total	2929	2403
Exposed	577	292
Other	89	30
Total	**6218**	**6220**
ORV Control Area		
Water	29	253
Wetland Emergent	169	12
Riparian Shrub	41	10
Riparian Forest	2	105
Wetland Total	241	380
Grassland	78	0
Shrub Grass	435	186
Shrubland	236	403
Dense Shrubland	19	44
Very Dense Shrubland	0	0

Table 2
Reference Vegetation Study Area Acreages

Cover Type	Reference Acreage	Existing Acreage
Upland Total	768	633
Exposed	21	17
Other	1	1
Total	**1031**	**1031**
Red Zone		
Water	6	2
Wetland Emergent	27	63
Riparian Shrub	8	0
Riparian Forest	1	47
Wetland Total	42	112
Grassland	2	4
Shrub Grass	129	36
Shrubland	158	186
Dense Shrubland	8	50
Very Dense Shrubland	0	35
Upland Total	297	311
Exposed	93	9
Other	0	<1
Total	**432**	**432**
Yellow Zone		
Water	276	731
Wetland Emergent	266	94
Riparian Shrub	289	333
Riparian Forest	43	30

Table 2
Reference Vegetation Study Area Acreages

Cover Type	**Reference Acreage**	**Existing Acreage**
Wetland Total	874	1188
Grassland	2	73
Shrub Grass	164	37
Shrubland	121	111
Dense Shrubland	6	1
Very Dense Shrubland	<1	0
Upland Total	293	222
Exposed	259	16
Other	0	0
Total	**1426**	**1426**
Green Zone		
Water	2	0
Wetland Emergent	1	6
Riparian Shrub	<1	7
Riparian Forest	6	7
Wetland Total	9	20
Grassland	6	0
Shrub Grass	152	53
Shrubland	281	303
Dense Shrubland	9	<1
Very Dense Shrubland	<1	0
Upland Total	448	356
Exposed	92	179
Other	0	0
Total	**549**	**555**

Appendix A
Problems Encountered During Data Analysis

Photo interpretation and photo quality

- Photo interpretation of the current and historic cover types were done by two different people. It is notoriously difficult to estimate percent plant cover accurately and consistently among different people (Barbour et al. 1999).

- The photos from 1964 and 1971 are much larger in scale and therefore show more detail, which is reflected in the map. There was more "lumping" done for the existing vegetation map.

- The photos are of a different type: black and white versus infrared.

- The 1971 and 1964 photos were of fairly poor quality (out of focus, over-exposed). This probably led to an overestimation of grassland and exposed cover types because of the difficulty in recognizing shrubs and the difficulty in differentiating between bare, reflected soil conditions (exposed) and shrub grass cover type (only 5% shrub cover needed).

- The old photos did not have enough overlap to compensate for curve distortion. Some adjacent photos had no overlap.

- The 1994 photos may not reflect the existing condition, particularly in the ORV park, because they are nearly six years old.

Land area

- There is a discrepancy in the amount of land area that is covered by the three sets of photos. The new photos were taken during high water conditions (March 28, 1994) while the old photos were taken at mid-level (June 29, 1971) and low water (September 9, 1964) conditions. As stated above, there was not have enough overlap to compensate for curve distortion in the old photos, some boundaries do not match up (Moses Lake shoreline, for example).

- Due to a lack of control points on the some of the sections of the historic photos, the set of photos had to be treated as one image that was registered to the existing coordinate system. The image was rotated around a central point to fit it into the map. This introduced a minimum 30% error at the margins of the image (the study area boundaries). For example, the boundary along Moses Lake was clipped by a few hundred meters to ensure that the same number of acres were used in the comparisons.

Cover typing

- It is difficult to differentiate upland types from wetland types. Since the difference between these types depends on plant species composition and it is often difficult to determine this from a photo, often the interpreter must make assumptions. Usually the proximity to water is the deciding factor.

- It is particularly difficult to differentiate between grassland, exposed, and wetland emergent cover types. Late in the season, exposed areas that have been under water will support vegetation, sometimes dense and lush wetland plant communities; hence these will be classified as wetland emergent. But, early in the season, before the plants have an opportunity to grow, the same areas will be classified as exposed (such as exposed mud flats). Comparing the amount of wetland emergent and exposed areas between different water levels may not provide an accurate assessment of changes over time.

- It is difficult to differentiate the riparian shrub cover type from the riparian forest cover type since it is determined by the height of woody species.

- Designations based on percent plant cover are arbitrary with regards to actual plant communities. For example, the same plant communities occur in the dense shrubland, shrubland, and shrub grass cover types.

- Most importantly, the *quality* of the habitat is not a factor in determining the appropriate cover type. We can compare the number of acres of shrubland in 1964 compared to the number of acres of shrubland in 1994, but this does not tell us about changes in the quality of the habitat or its elements. For example, a rabbitbrush shrubland community has far less wildlife value than a big sagebrush community of the same cover type.